

Electricity and Magnetism, Turkey, UME (Tubitak Ulusal Metroloji Enstitüsü)

Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
DC voltage sources: single values	Solid state voltage standard	Comparison	1	1	V			30	nV	2	95%	No			1
DC voltage sources: single values	Standard cell, solid state voltage standard	Comparison	1.018	1.018	V			50	nV	2	95%	No			2
DC voltage sources: single values	Solid state voltage standard	Comparison	10	10	V			150	nV	2	95%	No			3
DC voltage sources: single values	Solid state voltage standard	Comparison	1	1	V			0.4	µV/V	2	95%	Yes			4
DC voltage sources: single values	Standard cell, solid state voltage standard	Comparison	1.018	1.018	V			0.4	µV/V	2	95%	Yes			5
DC voltage sources: single values	Solid state voltage standard	Comparison	10	10	V			0.4	µV/V	2	95%	Yes			6
DC voltage sources: low values	DC voltage source, multifunction calibrator	Voltage standard, reference divider	0.001	1	mV			Q[20, N], N source noise in nV	nV	2	95%	No			7.1
DC voltage sources: low values	DC voltage source, multifunction calibrator: voltage U	Voltage standard, reference divider	1	100	mV			(3E-06 U + 2E-05), U in mV	mV	2	95%	No			7.2
DC voltage sources: low values	DC voltage source, multifunction calibrator	Voltage standard, reference divider	0.1	10	V			3	µV/V	2	95%	Yes			7.3
DC voltage sources: low values	DC voltage source, multifunction calibrator	Multifunction transfer standard	0.1	0.1	V			1	µV/V	2	95%	Yes			7.3a
DC voltage sources: low values	DC voltage source, multifunction calibrator	Multifunction transfer standard	1	1	V			1	µV/V	2	95%	Yes			7.3b
DC voltage sources: low values	DC voltage source, multifunction calibrator	Multifunction transfer standard	10	10	V			1	µV/V	2	95%	Yes			7.3c
DC voltage sources: intermediate values	DC voltage source, multifunction calibrator	Voltage standard, reference divider	10	1000	V			3	µV/V	2	95%	Yes			8

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DC voltage meters: very low values	Nanovoltmeter, microvoltmeter	Voltage standard, reference divider	1	200	µV			120	nV	2	95%	No			9
DC voltage meters: very low values	Nanovoltmeter, microvoltmeter	Direct with JAVS	2E-04	0.001	V			10	µV/V	2	95%	Yes			10.1
DC voltage meters: intermediate values	DC voltmeter, multimeter, multifunction transfer standard	Direct with JAVS	0.001	1	V			0.4	µV/V	2	95%	Yes			10.2
DC voltage meters: intermediate values	DC voltmeter, multimeter, multifunction transfer standard	Direct with JAVS	1	10	V			0.03	µV/V	2	95%	Yes			10.3
DC voltage meters: intermediate values	DC voltmeter, multimeter, multifunction transfer standard	Voltage standard, reference divider	10	1000	V			3	µV/V	2	95%	Yes			11
DC voltage ratios: up to 1100V	Resistive divider	Comparison with reference divider	0.01	0.01		Input voltage	1000 V	2.5E-06		2	95%	Yes			12.1
DC voltage ratios: up to 1100V	Resistive divider	Comparison with reference divider	0.1	0.1		Input voltage	100 V	3E-06		2	95%	Yes			12.2
DC resistance standards and sources: low values	Fixed resistor	Direct current comparator bridge	0.1	0.1	mΩ	Oil/air bath temperature	23 °C	7	µΩ/Ω	2	95%	Yes			13
DC resistance standards and sources: low values	Fixed resistor	Direct current comparator bridge	1	10	mΩ	Resistance	1 mΩ, 10 mΩ	5	µΩ/Ω	2	95%	Yes			14
						Oil/air bath temperature	23 °C								
DC resistance standards and sources: low values	Fixed resistor	Direct current comparator bridge	100	100	mΩ	Oil/air bath temperature	23 °C	3	µΩ/Ω	2	95%	Yes			15
DC resistance standards and sources: low values	Fixed resistor	Direct current comparator bridge	1	1	Ω	Oil/air bath temperature	23 °C	0.09	µΩ/Ω	2	95%	Yes			16
						Power	2.5 mW								
DC resistance standards and sources: intermediate values	Fixed resistor	Direct current comparator bridge	10	10	Ω	Oil/air bath temperature	23 °C	0.2	µΩ/Ω	2	95%	Yes			17
						Power	2.5 mW								
DC resistance standards and sources: intermediate values	Fixed resistor	Direct current comparator bridge	100	100	Ω	Oil/air bath temperature	23 °C	0.07	µΩ/Ω	2	95%	Yes			17.1
						Power	2.5 mW								

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DC resistance standards and sources: intermediate values	Fixed resistor	Direct current comparator bridge	1000	1000	Ω	Oil/air bath temperature	23 °C	0.2	μΩ/Ω	2	95%	Yes			17.2
						Power	2.5 mW								
DC resistance standards and sources: intermediate values	Fixed resistor	Direct current comparator bridge	10	10	kΩ	Oil/air bath temperature	23 °C	0.1	μΩ/Ω	2	95%	Yes			18
						Power	2.5 mW								
DC resistance standards and sources: intermediate values	Fixed resistor	High resistance ratio bridge	100	100	kΩ	Air bath temperature	23 °C	1.5	μΩ/Ω	2	95%	Yes			19
DC resistance standards and sources: intermediate values	Fixed resistor	High resistance ratio bridge	1	1	MΩ	Air bath temperature	23 °C	3	μΩ/Ω	2	95%	Yes			20
DC resistance standards and sources: intermediate values	Resistance box	Direct measurement	1	1E+06	Ω			15 to 200	μΩ/Ω	2	95%	Yes			21
DC resistance standards and sources: high values	Three terminal resistor	High resistance ratio bridge	10	100	MΩ	Resistance	10 MΩ and 100 MΩ	5	μΩ/Ω	2	95%	Yes			22
						Air bath temperature	23 °C								
DC resistance standards and sources: high values	Three terminal resistor	High resistance ratio bridge	1	1	GΩ	Air bath temperature	23 °C	12	μΩ/Ω	2	95%	Yes			23
DC resistance standards and sources: high values	Resistance box	Direct measurement	1E+06	1E+09	Ω			15 to 200	μΩ/Ω	2	95%	Yes			24
DC resistance standards and sources: high values	Three terminal resistor	Modified Wheatstone bridge	10	100	GΩ	Maximum voltage	1000 V	50 to 150	μΩ/Ω	2	95%	Yes			25
						Air bath temperature	23 °C								
DC resistance standards and sources: high values	Three terminal resistor	Modified Wheatstone bridge	1	100	TΩ	Maximum voltage	1000 V	0.7	mΩ/Ω	2	95%	Yes			26
						Air bath temperature	23 °C								

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DC resistance standards and sources: high values	Three terminal resistor	Modified Wheatstone bridge	1	1	PΩ	Maximum voltage	1000 V	1	mΩ/Ω	2	95%	Yes			27
						Air bath temperature	23 °C								
DC resistance standards and sources: standards for high current	DC shunt	Direct current comparator bridge	0.1	10	mΩ	Resistance	0.1 mΩ, 1 mΩ and 10 mΩ	5 to 10	μΩ/Ω	2	95%	Yes			28
						Maximum current	100 A								
						Oil/air bath temperature	23 °C								
DC resistance standards and sources: multiple ranges	multipunction calibrators	Direct current comparator bridge	1	1E+09	Ω	Resistance	1 Ω, 10 Ω, 100 Ω, 1E+03 Ω, 1E+04 Ω, 1E+05 Ω, 1E+06 Ω, 1E+07 Ω, 1E+08 Ω and 1E+09 Ω	1 to 50	μΩ/Ω	2	95%	Yes			29
DC resistance standards and sources: temperature coefficient	Fixed resistor, linear term	Direct current comparator bridge	0.02	200	μΩ/Ω/K	Temperature	20 °C to 25 °C	0.002	μΩ/Ω/K	2	95%	No			394
DC resistance standards and sources: temperature coefficient	Fixed resistor, quadratic term	Direct current comparator bridge	0.02	100	μΩ/Ω/K ²	Temperature	20 °C to 25 °C	0.002	μΩ/Ω/K ²	2	95%	No			395
DC resistance meters: low values	Microohmmeter, multimeter, multifunction transfer standard	Direct measurement	1E-04	0.1	Ω	Resistance	decadic values	1000 to 50	μΩ/Ω	2	95%	Yes			30
DC resistance meters: intermediate values	Ohmmeter, multimeter, multifunction transfer standard	Direct measurement	1	1E+06	Ω	Resistance	decadic values	15 to 200	μΩ/Ω	2	95%	Yes			31
DC resistance meters: intermediate values	Teraohmmeter, multimeter, multifunction transfer standard	Direct measurement	1E+07	1E+09	Ω	Resistance	decadic values	20 to 50	μΩ/Ω	2	95%	Yes			32.a
DC resistance meters: high values	Teraohmmeter, multimeter, multifunction transfer standard	Direct measurement	1E+09	1E+15	Ω	Resistance	decadic values	50 to 2000	μΩ/Ω	2	95%	Yes			32.b

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DC current sources: low values	Current generator	Direct measurement	0.1	2	pA			100 to 25	mA/A	2	95%	Yes			328
DC current sources: low values	Current generator	Direct measurement	2	20	pA			25	mA/A	2	95%	Yes			329
DC current sources: low values	Current generator	Direct measurement	20	200	pA			20	mA/A	2	95%	Yes			330
DC current sources: low values	Current generator, multifunction calibrator	Direct measurement	0.2	2	nA			0.6	mA/A	2	95%	Yes			331
DC current sources: low values	Current generator, multifunction calibrator	Direct measurement	2	2000	nA			0.4	mA/A	2	95%	Yes			332
DC current sources: low values	Current generator	Direct measurement	2	10	µA			0.25	mA/A	2	95%	Yes			333
DC current sources: low values	Current generator, multifunction calibrator	DC current shunt, voltmeter	1E-05	1E-04	A			35	µA/A	2	95%	Yes			36.1
DC current sources: intermediate values	Current generator, multifunction calibrator	DC current shunt, voltmeter	1E-04	1	A			10	µA/A	2	95%	Yes			36.2
DC current sources: intermediate values	Current generator, multifunction calibrator	DC current shunt, voltmeter	1	10	A			25	µA/A	2	95%	Yes			36.3
DC current sources: intermediate values	Current generator, multifunction calibrator	DC current shunt, voltmeter	10	20	A			30	µA/A	2	95%	Yes			37.1
DC current sources: high values	Current generator	DC current shunt, voltmeter	20	100	A			50	µA/A	2	95%	Yes			37.2
DC current sources: transconductance ratio	Transconductance amplifier	DC current shunt, voltmeter	1	100	S	Current	1 A to 100 A	100	µS/S	2	95%	Yes			370
DC current meters: low values	Picoammeter, nanoammeter	Direct measurement	0.1	1	nA			30 to 7	mA/A	2	95%	Yes			334
DC current meters: low values	Picoammeter, nanoammeter	Direct measurement	1	100	nA			15 to 5	mA/A	2	95%	Yes			335
DC current meters: low values	Picoammeter, nanoammeter	Direct measurement	0.1	10	µA			13 to 3	mA/A	2	95%	Yes			336
DC current meters: low values	Nanoammeter, multimeter, multifunction transfer standard	Shunt/voltmeter	1E-05	1E-04	A			10	µA/A	2	95%	Yes			43.1

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DC current meters: intermediate values	Nanoammeter, multimeter, multifunction transfer standard	Shunt/voltmeter	1E-04	1	A			10	µA/A	2	95%	Yes			43.2
DC current meters: intermediate values	Multimeter, multifunction transfer standard	Shunt/voltmeter	1	2	A			20	µA/A	2	95%	Yes			44
DC current meters: intermediate values	Current comparator	Shunt/voltmeter	2	20	A			35	µA/A	2	95%	Yes			44.1
DC current meters: high values	Current transducer	Shunt/voltmeter	20	100	A			50	µA/A	2	95%	Yes			44.2
AC resistance: real component	Fixed resistor	Substitution	10	10	Ω	Frequency	100 Hz to 10 kHz	10	µΩ/Ω	2	95%	Yes			45
AC resistance: real component	Fixed resistor	Substitution	100	100	Ω	Frequency	10 Hz to 10 kHz	10	µΩ/Ω	2	95%	Yes			46
AC resistance: real component	Fixed resistor	Substitution	1	1	kΩ	Frequency	10 Hz to 10 kHz	10	µΩ/Ω	2	95%	Yes			47
AC resistance: real component	Fixed resistor	Substitution	10	10	kΩ	Frequency	10 Hz to 10 kHz	20	µΩ/Ω	2	95%	Yes			48
AC resistance: meters	LCR meter	Direct comparison	0.01	10	kΩ	Frequency	10 Hz to 10 kHz	200	µΩ/Ω	2	95%	Yes			49
Capacitance: low loss capacitor	Standard capacitor: fused silica, air capacitor	Substitution	10	1000	pF	Frequency	1 kHz to 1 MHz	1.6 to 2500	µF/F	2	95%	Yes	Capacitance Matrix		50.1
Capacitance: low loss capacitor	Standard capacitor: air capacitor	Two terminal pair bridge	1	1	pF	Frequency	1 kHz	7	µF/F	2	95%	Yes			52
Capacitance: dielectric capacitor	Fixed capacitor, variable capacitor, capacitance box	Two terminal pair bridge	10	1000	nF	Frequency	1 kHz	50	µF/F	2	95%	Yes			53
Capacitance: dissipation factor for dielectric capacitors	Fixed capacitor, variable capacitor, capacitance box	Two terminal pair bridge	5E-06	3E-04		Capacitance	1 pF to 1000 pF	1E-05		2	95%	No			54
						Frequency	1 kHz								
Capacitance: dissipation factor for dielectric capacitors	Fixed capacitor, variable capacitor, capacitance box	Two terminal pair bridge	3E-04	1E-03		Capacitance	1000 pF to 1 µF	3E-04 to 1E-04		2	95%	No			55
						Frequency	1 kHz								
Capacitance: meters	Capacitance bridge, LCR meter	Direct comparison	1	1E+06	pF	Frequency	1 kHz	200	µF/F	2	95%	Yes			56
Inductance: self inductance, low values	Fixed inductor	Maxwell-Wien bridge	0.1	0.1	mH	Frequency	100 Hz to 100 kHz	120 to 750	µH/H	2	95%	Yes	Inductance Matrix		57.1

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Inductance: self inductance, intermediate values	Fixed inductor	Maxwell-Wien bridge	0.001	1	H	Frequency	60 Hz to 40 kHz	60 to 250	μH/H	2	95%	Yes	Inductance Matrix		57.2
Inductance: self inductance, intermediate values	Fixed thermostated inductor	Maxwell-Wien bridge	10	10	mH	Frequency	1 kHz	10	μH/H	2	95%	Yes			67
						Temperature stability	10 mK								
Inductance: self inductance, high values	Fixed inductor	Maxwell-Wien bridge	10	10	H	Frequency	60 Hz to 1 kHz	100 to 200	μH/H	2	95%	Yes	Inductance Matrix		57.3
Inductance: meters	LCR meter	Direct comparison	1E-04	10	H	Frequency	60 Hz, 100 Hz, 200 Hz, 400 Hz, 1 kHz, 4 kHz, 10 kHz, 40 kHz, 100 kHz	200 to 1000	μH/H	2	95%	Yes			80
AC voltage: AC/DC transfer difference at low voltages	Thermal voltage converter with amplifier, micropotentiometer, AC/DC transfer standard	Comparison	0.002	0.5	V	Frequency	10 Hz to 1 MHz	10 to 400	μV/V	2	95%	Yes	Matrix 1		81.1
AC voltage: AC/DC transfer difference at medium voltages	AC/DC transfer standard, thermal converter	Comparison	0.5	5	V	Frequency	10 Hz to 1 MHz	4 to 85	μV/V	2	95%	Yes	Matrix 1		81.2
AC voltage: AC/DC transfer difference at higher voltages	AC/DC transfer standard, thermal converter with range extender	Comparison	5	1000	V	Frequency	10 Hz to 1 MHz	7 to 85	μV/V	2	95%	Yes	Matrix 1		81.3
AC voltage up to 1000 V: sources	Multifunction calibrator	AC/DC transfer	0.002	1000	V	Frequency	10 Hz to 1 MHz	30 to 5000	μV/V	2	95%	Yes	Matrix 2		233.1
AC voltage up to 1000 V: meters	AC voltmeter, multimeter, multifunction transfer standard	AC/DC transfer	0.002	1000	V	Frequency	10 Hz to 1 MHz	15 to 1500	μV/V	2	95%	Yes	Matrix 3		245.1
AC voltage ratio: real component	Inductive voltage divider	Comparison with reference divider	0	1		Frequency	100 Hz, 400 Hz, 1 kHz	0.50E-06		2	95%	No		Each step of the three most significant dials, others at zero	371
AC voltage ratio: imaginary component	Inductive voltage divider	Comparison with reference divider	0	1		Frequency	100 Hz, 400 Hz, 1 kHz	5.00E-06		2	95%	No		Each step of the three most significant dials, others at zero	372

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AC voltage ratio: real component	Inductive voltage divider	Comparison with reference divider	0	1		Frequency	5 kHz, 10 kHz	1.00E-06		2	95%	No		Each step of the three most significant dials, others at zero	373
AC voltage ratio: imaginary component	Inductive voltage divider	Comparison with reference divider	0	1		Frequency	5 kHz, 10 kHz	5.00E-06		2	95%	No		Each step of the three most significant dials, others at zero	374
AC current: AC/DC transfer difference	Thermal current converter, shunt	Comparison	0.005	20	A	Frequency	10 Hz to 100 kHz	40 to 150	µA/A	2	95%	Yes	Matrix 4		257.1
AC current up to 100 A: sources	Multifunction calibrator, transconductance amplifier	AC/DC transfer	0.005	20	A	Frequency	10 Hz to 10 kHz	150 to 500	µA/A	2	95%	Yes	Matrix 5		357.1
AC current up to 100 A: meters	AC ammeter, multimeter, multifunction transfer standard	AC/DC transfer	0.005	20	A	Frequency	10 Hz to 100 kHz	180 to 750	µA/A	2	95%	Yes	Matrix 6		365.1
AC power and energy: single phase ($f \leq 400$ Hz), active power	Power meter, wattmeter	Direct comparison	0.75	4800	W	Voltage	60 V to 480 V	75	µW/VA	2	95%	Yes			277.a
						Current	0.05 A to 10 A								
						Power factor	1 to 0.25, inductive or capacitive								
						Frequency	50 Hz to 53 Hz								
AC power and energy: single phase ($f \leq 400$ Hz), active power	Power meter, wattmeter	Direct comparison	150	48000	W	Voltage	60 V to 480 V	100	µW/VA	2	95%	Yes			277.b
						Current	10 A to 100 A								
						Power factor	1 to 0.25, inductive or capacitive								
						Frequency	50 Hz to 53 Hz								
AC power and energy: three phase, active power	Power meter	Direct comparison	2.25	23040	W	Voltage	60 V to 480 V	130	µW/VA	2	95%	Yes			278.a
						Current	0.05 A to 16 A								
						Power factor	1 to 0.25, inductive or capacitive								
						Frequency	50 Hz to 53 Hz								

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AC power and energy: three phase, active power	Power meter	Direct comparison	720	230400	W	Voltage	60 V to 480 V	175	µW/V/A	2	95%	Yes			278.b
						Current	16 A to 160 A								
						Power factor	1 to 0.25, inductive or capacitive								
						Frequency	50 Hz to 53 Hz								
Magnetic fields below 50 kHz: DC magnetic flux	Fluxmeter	Measurement in a known field	1E-06	0.02	Wb			10	mWb/Wb	2	95%	Yes			287.9
Magnetic fields below 50 kHz: DC magnetic flux density	Magnetic flux density meter, magnetic field strength meter	Helmholtz coil	0.02	5	mT			3	mT/T	2	95%	Yes			287
Magnetic fields below 50 kHz: DC magnetic flux density	Magnetic flux density meter, magnetic field strength meter	Using calibrated split field coil	0.0001	0.016	T			Q[1E-06, 0.0028B], B magnetic flux density in Tesla	T	2	95%	No			287.1
Magnetic fields below 50 kHz: DC magnetic flux density	Magnetic flux density meter, magnetic field strength meter	Substituting by Hall-probe magnetometer	0.1	2.2	T			10	mT/T	2	95%	Yes			287.2
Magnetic fields below 50 kHz: AC magnetic flux density	Magnetic flux density meter, magnetic field strength meter	Using calibrated split field coil	100	5000	µT	Frequency	20 Hz to 50 Hz	16	mT/T	2	95%	Yes			287.10
Magnetic fields below 50 kHz: AC magnetic flux density	Magnetic flux density meter, magnetic field strength meter	Using calibrated split field coil	100	800	µT	Frequency	> 50 Hz to 500 Hz	16	mT/T	2	95%	Yes			287.11
Magnetic fields below 50 kHz: DC magnetic flux density per unit current	Field coils	Substituting by Hall-probe magnetometer	30	300	µT/A	Current	1 A	5	%	2	95%	Yes			287.3
Magnetic fields below 50 kHz: DC magnetic flux density per unit current	Field coils	Substituting by Hall-probe magnetometer	> 0.3	3	mT/A	Current	1 A	6.2	%	2	95%	Yes			287.4

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Magnetic fields below 50 kHz: DC magnetic flux density per unit current	Field coils	Substituting by Hall-probe magnetometer	> 0.1	50	mT/A	Current	1 to 30 A	1.4	%	2	95%	Yes		Higher values for coil constants can be measured on demand	287.5
Magnetic fields below 50 kHz: DC magnetic flux density per unit current	Field coils	Measurement by NMR teslameter	5.7	50	mT/A	Current	1 to 30 A	0.005	%	2	95%	Yes		Higher values for coil constants can be measured on demand	287.8
RF power: absolute power on coaxials	Power source, power meter: type N	Direct reading with thermistor mount	0.01	10	mW	Frequency	100 kHz to 500 kHz	44	mW/W	2	95%	Yes			300.1
RF power: absolute power on coaxials	Power source, power meter: type N	Direct reading with thermistor mount	0.01	10	mW	Frequency	500 kHz to 18 GHz	4 to 11	mW/W	2	95%	Yes			300
RF power: absolute power on waveguides	Power source: WR42	Direct reading with thermistor mount	0.01	10	mW	Frequency	18 GHz to 26.5 GHz	20	mW/W	2	95%	Yes			301
RF power: calibration factor on coaxials	Thermistor, power sensor: type N	Comparison with reference thermistor	0.8	1		Frequency	100 kHz	0.044		2	95%	No			303a
						Power level	1 mW								
RF power: calibration factor on coaxials	Thermistor, power sensor: type N	Comparison with reference thermistor	0.8	1		Frequency	200 kHz to 18 GHz	0.006 to 0.025		2	95%	No			304
						Power level	1 mW								
RF power: effective efficiency on coaxials	Thermistor: type N	Direct reading	0.9	1		Frequency	100 kHz to 1 GHz	5.6E-03		2	95%	No			306
						Power level	10 mW								
RF power: effective efficiency on coaxials	Thermistor: type N	Direct reading	0.9	1		Frequency	1 GHz to 18 GHz	6.6E-03		2	95%	No			307
						Power level	10 mW								
RF power: calibration factor on waveguides	Thermistor, power sensor: WR42	Comparison with reference thermistor	0.8	1		Frequency	18 GHz to 26.5 GHz	0.015 to 0.050		2	95%	No			305
						Power level	1 mW								
RF power: effective efficiency on waveguides	Thermistor: WR42	Direct reading	0.9	1		Frequency	18 GHz to 26.5 GHz	13.2E-03		2	95%	No			308
						Power level	10 mW								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Scattering parameters: reflection coefficient (Sii) on coaxials, real component	Passive devices: 3.5 mm	Vector network analyser	-1	1		Frequency	0.045 GHz to 26.5 GHz	0.016		2	95%	No			312
Scattering parameters: reflection coefficient (Sii) on coaxials, imaginary component	Passive devices: 3.5 mm	Vector network analyser	-1	1		Frequency	0.045 GHz to 26.5 GHz	0.016		2	95%	No			312.b
Scattering parameters: reflection coefficient (Sii) on coaxials, real component	Passive devices: type N	Vector network analyser	-1	1		Frequency	0.045 GHz to 18 GHz	0.021		2	95%	No			312.a
Scattering parameters: reflection coefficient (Sii) on coaxials, imaginary component	Passive devices: type N	Vector network analyser	-1	1		Frequency	0.045 GHz to 18 GHz	0.021		2	95%	No			312.c
Antenna properties: antenna factor	Dipole antenna	Standard antenna	-2	30	dB(1/m)	Frequency	30 MHz to 1 GHz	1.8	dB	2	95%	No			375
Antenna properties: antenna factor	Log periodic antenna	Standard antenna	-2	30	dB(1/m)	Frequency	200 MHz to 1 GHz	1.8	dB	2	95%	No			376
Antenna properties: antenna factor	Biconical antenna	Standard antenna	-2	30	dB(1/m)	Frequency	30 MHz to 300 MHz	1.8	dB	2	95%	No			377
Antenna properties: antenna factor	Bilog / hybrid antenna	Standard antenna	-2	30	dB(1/m)	Frequency	30 MHz to 1 GHz	1.8	dB	2	95%	No			378
Signal and pulse characteristics: pulse amplitude	Pulse and function generator	Oscilloscope	-5	5	V	Frequency	up to 500 MHz	25	mV/V	2	95%	Yes			314
Signal and pulse characteristics: pulse time parameters: rise time, fall time, pulse width and phase	Pulse generator	Externally triggered from Cs clock	3E-09	10	s	Frequency	0.01 Hz to 160 MHz	2E-09	s	2	95%	No			379
Signal and pulse characteristics: frequency modulation	Signal generator	Comparison by means of measuring receiver	1000	400E+03	Hz	Frequency	250 kHz to 1300 MHz	5E-02		2	95%	Yes			380

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Signal and pulse characteristics: amplitude modulation	Signal generator	Comparison by means of measuring receiver	1	99	%	Frequency	150 kHz to 1300 MHz	3E-02		2	95%	Yes			381
Signal and pulse characteristics: distortion and harmonic content	Signal generator	Comparison by means of audio analyzer	-99.99	0	dB	Frequency	20 Hz to 100 kHz	2	dB	2	95%	No			382
Signal and pulse characteristics: distortion and harmonic content	Signal generator	Comparison by means of spectrum analyzer	-90	20	dBm	Frequency	100 kHz to 26.5 GHz	3.5	dB	2	95%	No			383
RF voltage: RF-DC transfer difference	AC/DC transfer standard, thermal converter	Comparison	0.5	50	V	Frequency	1 MHz to 100 MHz	80 to 4000	µV/V	2	95%	Yes	Matrix 7		105.1
RF voltage sources	RF generator	Comparison	0.5	50	V	Frequency	1 MHz to 100 MHz	1000 to 5000	µV/V	2	95%	Yes	Matrix 8		384
RF voltage meters	RF voltmeter	Comparison	0.5	50	V	Frequency	1 MHz to 100 MHz	1000 to 5000	µV/V	2	95%	Yes	Matrix 8		385
Electrical conductivity: metallic materials	Metallic bar	Resistance and geometry	5	60	MS/m	Length	40 mm to 340 mm	1 to 10	1E-03	2	95%	Yes			386
						Height	< 5 mm								
						Width	< 20 mm								
						Temperature	20 °C to 23 °C								
Electrical conductivity: metallic materials	Reference material	Eddy current	11.54	58.69	MS/m	Temperature	20 °C	5 to 10	1E-03	2	95%	Yes			387
						Frequency	60 kHz								
Soft magnetic bulk materials: magnetic polarisation B	Rod, cylinder: magnetic polarisation B	Comparison with calibrated nickel sphere in VSM	0.001	0.1	T	Sample size	Up to 10 mm	Q[0.0001, 0.01B], B in T	T	2	95%	No			388
Soft magnetic bulk materials: coercive field strength	Rod, cylinder: coercive magnetic field H	Measurement in VSM	1000	80000	A/m	Sample size	Up to 10 mm	Q[100, 0.005H], H in A/m	A/m	2	95%	No			389
Soft magnetic bulk materials: magnetic saturation polarization B	Rod, cylinder: magnetic saturation polarization B	Comparison with calibrated nickel sphere in VSM	0.001	0.1	T	Sample size	Up to 10 mm	Q[0.0001, 0.01B], B in T	T	2	95%	No			390
Hard magnetic materials: magnetic moment	Cylinder, rectangular parallelepiped	Comparison with calibrated nickel sphere in VSM	3E-08	0.1	Am ²	Sample size	Up to 10 mm	1	%	2	95%	Yes			391

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Magnetic data storage media: signal amplitude of magnetic stripes	Magnetic stripes	Measurement in optical microscope using magnetooptic indicator films	1E-04	0.1	T			1	%	2	95%	Yes		Only the normal component of magnetic field is measured	392
Magnetic data storage media: surface profile of magnetic stripes	Magnetic stripes	Measurement in optical microscope using magnetooptic indicator films	0.01	10	mm			1	µm	2	95%	No			393

Electricity and Magnetism, Turkey, UME (Tubitak Ulusal Metroloji Enstitüsü)

Uncertainty table: Capacitance_Matrix

Capacitance for low loss capacitor, UME Internal Identifier: 50.1

	1 kHz	10 kHz	100 kHz	400 kHz	1 MHz
10 pF	1.6	100	200	200	200
100 pF	1.7	100	200	200	1000
1000 pF	7	100	250	600	2500

The expanded uncertainties given in this table are expressed in $\mu\text{F}/\text{F}$.

Electricity and Magnetism, Turkey, UME (Tubitak Ulusal Metroloji Enstitüsü)

Uncertainty table: Inductance_Matrix

Inductance: self inductance, low values, UME Internal Identifier: 57.1

Inductance: self inductance, intermediate values, UME Internal Identifier: 57.2

Inductance: self inductance, high values, UME Internal Identifier: 57.3

	60 Hz	100 Hz	200 Hz	400 Hz	1 kHz	4 kHz	10 kHz	40 kHz	100 kHz
100 µH	-	250	200	200	120	-	200	500	750
1 mH	-	100	100	80	80	-	150	250	-
10 mH	-	60	60	60	-	100	250	-	-
100 mH	-	80	70	70	70	80	200	-	-
1 H	120	80	80	80	60	-	-	-	-
10 H	150	100	100	100	200	-	-	-	-

The expanded uncertainties given in this table are expressed in µH/H.

Electricity and Magnetism, Turkey, UME (Tubitak Ulusal Metroloji Enstitüsü)**Uncertainty table: Matrix 1**

AC voltage: AC-DC transfer difference at low voltages, UME Internal Identifier: 81.1

AC voltage: AC-DC transfer difference at medium voltages, UME Internal Identifier: 81.2

AC voltage: AC-DC transfer difference at higher voltages, UME Internal Identifier: 81.3

	10 Hz	20 Hz	30 Hz to 20 kHz	50 kHz	100 kHz	200 kHz to 300 kHz	500 kHz	700 kHz to 1 MHz
2 mV	250	250	200	190	200	240	270	400
6 mV	120	110	110	120	140	175	200	350
10 mV	95	90	70	90	120	150	180	300
20 mV	80	75	70	70	80	120	150	250
60 mV	70	50	50	50	60	80	120	200
100 mV	40	25	15	25	40	60	90	150
200 mV / 500 mV	20	15	10	15	20	30	50	85
600 mV / 700 mV	10	8	6	8	10	20	30	50
1 V / 3 V	10	6	4	4	5	10	20	30
4 V / 5 V	17	7	7	8	9	15	25	35
6 V / 10 V	17	7	7	8	9	15	25	35
20 V	17	10	9	9	10	20	25	45
30 V / 50 V	30	20	12	15	15	23	-	-
60 V / 100 V	40	25	20	15	20	-	-	-
200 V	40	30	22	25	28	-	-	-
300 V	45	30	25	25	30	-	-	-
500 V	55	35	25	25	45	-	-	-
1000 V	65	45	35	45	85	-	-	-

The expanded uncertainties given in this table are expressed in $\mu\text{V/V}$.

Electricity and Magnetism, Turkey, UME (Tubitak Ulusal Metroloji Enstitüsü)

Uncertainty table: Matrix 2

AC voltage up to 1000 V: sources, UME Internal Identifier: 233.1

	10 Hz	20 Hz	40 Hz to 20 kHz	50 kHz	100 kHz	300 kHz	500 kHz	1 MHz
2 mV	1200	1200	1200	1300	2000	3000	4000	5000
2 mV / 100 mV	250	200	150	200	250	500	1000	2000
100 mV / 400 mV	150	70	60	70	100	200	350	800
0.4 V / 6 V	100	40	30	40	50	150	200	300
6 V / 20 V	100	50	40	50	60	150	200	400
20 V / 40 V	100	50	40	50	60	200	-	-
40 V / 200 V	100	50	40	50	90	-	-	-
200 V / 1000 V	100	60	60	200	500	-	-	-

The expanded uncertainties given in this table are expressed in $\mu\text{V/V}$.

Electricity and Magnetism, Turkey, UME (Tubitak Ulusal Metroloji Enstitüsü)**Uncertainty table: Matrix 3**

AC voltage up to 1000 V: meters, UME Internal Identifier: 245.1

	10 Hz	20 Hz	40 Hz to 50 kHz	100 kHz	200 kHz	500 kHz	700 kHz	1 MHz
2 mV	650	600	400	500	750	800	1000	1500
2 mV / 20 mV	200	150	170	200	250	300	500	800
20 mV / 60 mV	110	90	80	90	150	170	260	350
60 mV / 100 mV	90	70	60	70	90	160	220	320
100 mV / 200 mV	60	40	35	40	80	150	200	300
200 mV / 600 mV	50	40	25	35	75	150	150	250
0.6 V / 2 V	50	35	20	25	50	120	140	250
2 V / 6 V	50	35	15	25	40	100	140	200
6 V / 10 V	30	20	15	25	35	100	140	200
10 V / 20 V	25	20	15	25	35	110	150	200
20 V / 60 V	30	25	25	35	45	-	-	-
60 V / 100 V	35	30	30	40	60	-	-	-
100 V / 200 V	35	30	30	40	-	-	-	-
200 V / 600 V	40	40	35	50	-	-	-	-
600 V / 1000 V	60	50	40	150	-	-	-	-

The expanded uncertainties given in this table are expressed in $\mu\text{V/V}$.

Electricity and Magnetism, Turkey, UME (Tubitak Ulusal Metroloji Enstitüsü)**Uncertainty table: Matrix 4**

AC current: AC/DC transfer difference, UME Internal Identifier: 257.1

	10 Hz	20 Hz	30 Hz	40 Hz	500 Hz	1 kHz	5 kHz	10 kHz	20 kHz	50 kHz	70 kHz	100 kHz
5 mA	40	40	40	40	40	40	40	40	40	50	60	80
10 mA	40	40	40	40	40	40	40	40	40	50	60	80
20 mA	40	40	40	40	40	40	40	40	40	50	60	80
30 mA	50	50	50	50	50	50	50	50	50	60	65	85
50 mA	50	50	50	50	50	50	50	50	50	60	65	85
100 mA	60	60	60	60	60	60	60	60	60	70	80	90
200 mA	60	60	60	60	60	60	60	60	60	75	85	95
300 mA	60	60	60	60	60	60	60	60	65	80	90	100
500 mA	60	60	60	60	60	60	60	60	70	85	95	105
1 A	70	70	70	70	70	70	70	70	75	90	100	110
2 A	70	70	70	70	70	70	70	70	80	95	105	115
3 A	80	80	80	80	80	80	80	80	85	-	-	-
5 A	90	90	90	90	90	90	90	90	90	-	-	-
10 A	100	100	100	100	100	100	100	100	130	-	-	-
20 A	110	110	110	110	110	110	110	110	110	150	-	-

The expanded uncertainties given in this table are expressed in $\mu\text{A}/\text{A}$.

Electricity and Magnetism, Turkey, UME (Tubitak Ulusal Metroloji Enstitüsü)**Uncertainty table: Matrix 5**

AC current up to 100 A: sources, UME Internal Identifier: 357.1

	10 Hz	20 Hz	30 Hz	40 Hz	500 Hz	1 kHz	5 kHz	10 kHz
5 mA	150	150	150	150	150	150	250	300
10 mA	150	150	150	150	150	150	250	300
20 mA	150	150	150	150	150	150	250	300
30 mA	150	150	150	150	150	150	250	300
50 mA	150	150	150	150	150	150	250	300
100 mA	150	150	150	150	150	150	250	300
200 mA	150	150	150	150	150	150	250	300
300 mA	150	150	150	150	150	150	250	300
500 mA	150	150	150	150	150	150	250	300
1 A	150	150	150	150	150	150	250	300
2 A	150	150	150	150	150	150	250	300
3 A	150	150	150	150	150	150	300	-
5 A	150	150	150	150	150	150	300	-
10 A	200	200	200	200	200	200	500	-
20 A	200	200	200	200	200	200	500	-

The expanded uncertainties given in this table are expressed in $\mu\text{A/A}$.

Electricity and Magnetism, Turkey, UME (Tubitak Ulusal Metroloji Enstitüsü)**Uncertainty table: Matrix 6**

AC current up to 100 A: meters, UME Internal Identifier: 365.1

	10 Hz	20 Hz	30 Hz	40 Hz	500 Hz	1 kHz	5 kHz	10 kHz	50 kHz	100 kHz
5 mA	180	180	180	180	180	180	250	250	500	750
10 mA	180	180	180	180	180	180	250	250	500	750
20 mA	180	180	180	180	180	180	250	250	500	750
30 mA	180	180	180	180	180	180	250	250	500	750
50 mA	180	180	180	180	180	180	250	250	500	750
100 mA	180	180	180	180	180	180	250	250	500	750
200 mA	180	180	180	180	180	180	250	250	500	-
300 mA	180	180	180	180	180	180	350	350	500	-
500 mA	180	180	180	180	180	180	350	350	500	-
1 A	180	180	180	180	180	180	350	350	500	-
2 A	180	180	180	180	180	180	350	350	-	-
5 A	200	200	200	200	200	200	350	350	-	-
10 A	250	250	250	250	250	250	550	550	-	-
20 A	250	250	250	250	250	250	550	550	-	-

The expanded uncertainties given in this table are expressed in $\mu\text{A}/\text{A}$.

Electricity and Magnetism, Turkey, UME (Tubitak Ulusal Metroloji Enstitüsü)

Uncertainty table: Matrix 7

RF voltage: RF/DC transfer difference, UME Internal Identifier: 105.1

	1 MHz	3 MHz	10 MHz	20 MHz	30 MHz	50 MHz	70 MHz	100 MHz
0.5 V	150	150	180	200	350	700	1500	3500
1 V	120	120	150	200	300	600	1400	3000
2 V	100	100	100	150	250	550	1300	2700
3 V / 5 V	80	80	100	140	230	550	1200	2200
10 V	100	100	150	150	250	600	1200	2800
20 V	150	150	150	200	300	650	1500	3000
30 V	200	200	200	250	350	700	2000	3500
50 V	220	250	300	300	400	750	2500	4000

The expanded uncertainties given in this table are expressed in $\mu\text{V/V}$.

Electricity and Magnetism, Turkey, UME (Tubitak Ulusal Metroloji Enstitüsü)

Uncertainty table: Matrix 8

RF voltage: sources, UME Internal Identifier: 384

RF voltage: meters, UME Internal Identifier: 385

	1 MHz to 30 MHz	30 MHz to 70 MHz	70 MHz to 100 MHz
0.5 V	1000	2000	5000
1 V	1000	2000	5000
2 V	1000	2000	5000
3 V / 5 V	1000	2000	5000
10 V	1000	2000	5000
20 V	1000	2000	5000
30 V	1000	2000	5000
50 V	1000	2000	5000

The expanded uncertainties given in this table are expressed in $\mu\text{V/V}$.